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The influence of race, sexual orientation and gender identity on mental health, substance use, and academic persistence during the COVID-19 pandemic: A cross-sectional study from a national sample of college students in the healthy minds study

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ABSTRACT

Purpose: This study seeks to characterize substance use, mental health, and academic persistence in college students during the COVID-19 pandemic, emphasizing variations by race, sexual orientation, and gender identity
Methods: National samples (n = 146,810) of undergraduate students from the Healthy Minds Study were compared in two time periods: Fall 2017-Winter 2020 (pre-COVID) and March-December 2020. Descriptive statistics were conducted including t-tests/chi square tests comparing differences between time periods. Logistic regressions were estimated for main outcomes: substance use (licit, illicit, none), anxiety and/or depression symptoms, and academic persistence (student confidence that they will finish their degree). Marginal effects of race, sexual orientation, and gender identity were reported for all logistic regressions.
Results: In March-December 2020, students had 1.70 higher odds of screening positive for anxiety and/or depression compared to pre-COVID semesters. Latinx, Black, and "other" race/ethnicity had significantly higher probabilities of screening positive, as did transgender and gender non-conforming (TGNC) and lesbian, gay, bisexual, and queer (LGBQ) students.;Students had 0.43 times lower odds of reporting substance use in March-December 2020. Asian, Black, and Latinx students had significantly lower probabilities of reporting substance use, as did TGNC and LGBQ students.; During the pandemic, most students (86.7%) report at least 1 day of academic impairment (emotional/mental difficulties that hurt academic performance) in the last month due to mental health (up from 79.9% pre-pandemic).
Conclusions: Using the most comprehensive mental health data in college student populations, this is the first study to describe the impact of the pandemic on undergraduate students' substance use, mental health, and academic persistence/impairment.

1. Introduction

Adolescents and young adults (AYA) experience substantial developmental changes between the ages of 18 and 25, a time of newfound autonomy and, for many, initiation or intensification of substance use behaviors (Casey, Jones, and Hare 2008; Uchitel et al. 2019). The majority (75%) of lifetime mental illnesses onset by age 24, which corresponds with this developmental timeframe (Kessler et al. 2005). Data from 2019 show that 39% of AYA used illicit drugs in the prior year, such as marijuana, cocaine, and heroin (Lipari 2019). This developmental stage also coincides with the traditional college years, and there are more than 22 million AYA enrolled in post-secondary education in the United States (US) (NCES 2019). Prior to the COVID-19 pandemic, more than half of full-time college students reported drinking alcohol in the past month, of which 33% engaged in binge drinking behaviors (defined as consuming 5 or more drinks (male), 4 or more drinks (female), 4 or 5 drinks (not female or male) in 2 hours) (NIAAA 2021). Electronic cigarette use in college student populations has also increased, with 34% of students reporting vaping in the past 12 months (Johnston et al. 2019). Prior research has shown that licit and illicit substance use among college students can be associated with poor academic performance, college drop-out, and future unemployment (Welsh, Shentu, and Sarvey 2019).

Abbreviations: AYA, adolescents and young adults; HMS, Healthy Minds Study; TGNC, transgender and gender nonconforming; LGBQ, lesbian, gay, bisexual, queer.

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Prior to the pandemic, substance use trends for college students were on the rise, especially troubling when considering simultaneous increases in the prevalence of anxiety and depression (Lipson, Lattie, and Eisenberg 2019). National data reveal that over one-third of college students screen positive for clinically-significant symptoms of anxiety or depression (Daniel Eisenberg et al. 2007). Mental health in college is a strong predictor of academic performance and student retention (Arria et al. 2013; Daniel Eisenberg, Golberstein, and Hunt 2009; Lipson and Eisenberg 2018). One longitudinal study found that depression is associated with a two-fold increase in the likelihood of dropping out or 'stopping out' of college without graduating, even when controlling for prior academic performance (high school grades and test scores) (Daniel Eisenberg, Golberstein, and Hunt 2009). Students with co-occurring symptoms of anxiety and depression were even more likely to have lower grades (Daniel Eisenberg, Golberstein, and Hunt 2009).

Similarly, substance use is a predictor of academic performance and retention. Marijuana use has been shown to predict discontinuous enrollment in the last two years of college, particularly among students with depressive symptoms or a depression diagnosis (Arria et al. 2015). Among undergraduates who report intentions to pursue graduate studies, alcohol dependence during college is associated with decreased likelihood of actually enrolling in graduate school (Arria et al. 2020). A report from the Center on Young Adult Health and Development indicates that excessive drinking and drug use not only causes short-term academic problems, such as diminished academic performance, but can have long-term consequences on academic persistence toward degree completion (Arria et al. 2018).

The COVID-19 pandemic has exacerbated known risk factors for depression, anxiety, and substance use (Panchal, Kamal, and 2021 2021). Quarantine and social distancing protocols increased feelings of loneliness and isolation (Holt-Lunstad 2020). For many students, there are also economic repercussions of the pandemic, creating additional financial stress, another key risk factor for mental health and substance use (Daniel Eisenberg et al. 2018). Feelings of grief due to pandemic-related hardships, including loss of loved ones, continue to affect millions worldwide (Verdery et al. 2020). There is ample evidence that communities of color and low-income populations were, and continue to be, disproportionately affected by the pandemic, including through the risk factors noted above (CDC 2020). Additionally, sexual and gender minorities represent marginalized communities facing unique psychological, economic, and physiological challenges (Moore et al. 2021). COVID-19-specific risk factors for declines in mental health among sexual and gender minority college students include financial stress, pandemic-related difficulties, and being witness to discrimination (Parchem et al. 2021). One study found that 60% of sexual and gender minority college students were experiencing psychological distress, anxiety, and depression during the pandemic (Moore et al. 2021).

The effect of the pandemic on mental health and substance use among US adults has been well documented.(Jones, Mitra, and Bhuiyan 2021; Roberts et al. 2021; Saeed et al. 2022; Wu et al. 2021) In June 2020, the CDC reported that 13% of Americans indicated initiating or increasing substance use as a coping mechanism for stressors related to COVID-19 (Czeisler 2020, 24). However, prior research has yet to explore relationships between student mental health and substance use during the COVID-19 pandemic on a national scale. To understand the on-going effects of the pandemic in college student populations, large-scale data are needed. There is also a need to understand how mental health and substance use are affecting students academically in the context of the pandemic. Using large-scale national data, the purpose of the present study is to characterize mental health, substance use, and academic persistence in a diverse sample of college students by comparing data from before (Fall 2017-Winter 2020) and during the early months of the pandemic (March-December 2020). A secondary aim is to investigate whether these outcomes differ by race, sexual orientation, or gender identity.

2. Materials and methods

2.1. Data

The analytic sample comes from four waves (2017-2020) of the *Healthy Minds Study (*HMS*)*, an annual cross-sectional survey of college students (Eisenberg and Lipson 2020). HMS reports on demographics, mental health, substance use, and academic outcomes for college and university students in the US. Informed consent, and student response data, are electronically collected through Qualtrics. All research is approved by relevant institutional review boards.

A random sample of students is selected from the full population at each HMS institution and is invited to participate. At each institution with more than 4,000 students, the HMS team recruits a random sample of 4,000 degree-seeking students from the full population. At institutions with less than 4,000 students, all students are invited to participate. To incentivize participation, students were informed of their eligibility for one of several prizes totaling $2,000 annually. Incentives were not contingent on participation. Survey response rates were as follows: 24% in 2017-2018, 16% in 2018-2019, 15% in 2019-2020, and 14% in Fall 2020. To minimize the effect of non-response bias, the HMS research group constructs sample probability weights using administrative data from each participating institution (Eisenberg and Lipson 2020). Weights are assigned to each survey respondent, such that those less likely to respond are given a larger weight (Eisenberg and Lipson 2020). Sample weights were applied in all stages of the present analysis. Further details about the HMS study design have been reported extensively in prior publications (Goodwill and Zhou 2020; Lipson et al. 2022; Lipson and Eisenberg 2018; Healthy Minds Network and American College Health Association 2020).

2.2. Sample

Inclusion criteria consist of full-time, undergraduate students (bachelor degree-seeking) between the ages of 18 and 30 with complete race, gender identity, and sexual orientation data. The analytic sample includes data from students at 78 colleges and universities, making this one of the largest known studies of its kind.

2.3. Outcomes

Substance use was measured through students' responses to the question, *"Over the past 30 days, have you used any of the following drugs? (Select all that apply)."* Alcohol use was identified with the question, *"Over the past 2 weeks, did you drink any alcohol? (Yes/No)."* Positive responses to alcohol use or tobacco use (measured in the first question) were classified as licit substance use (yes/no). Positive responses to marijuana, cocaine, heroin, opioids, methamphetamine, stimulants, ecstasy, hallucinogens, benzodiazepines, or kratom were classified as illicit substance use (yes/no). Students reporting both licit and illicit substance use were categorized as illicit. Binge drinking was identified with the question, "*Over the past 2 weeks, about how many times did you have 4 [female]/5[male or 5[not female or male] or more alcoholic drinks in a row? (0 times, 1 time, 2 times, 3 to 5 times, 6 to 9 times, 10 or more times, Don't know)."* Binge drinking was dichotomized to a binary response variable, with "0 times" indicating "no" binge drinking and 1 or more times as "yes" binge drinking. Binge drinking was not included as a main outcome as it significantly overlaps with licit substance use (57% of students reporting licit substance use indicate binge drinking).

Mental health status was determined through anxiety and depression measures. Anxiety was measured with the Generalized Anxiety Disorder-7 (GAD-7) scale, with a score greater than or equal to 10 indicating a positive screen (Spitzer et al. 2006). Depression was measured using the Patient Health Questionnaire-9 (PHQ-9), for which a positive screen is a score greater than or equal to 10 (Kroenke, Spitzer, and Williams 2001).

It is important to note that positive screens for anxiety (28%) and depression (32%) were similar, and 21.2% of students screened positive for both anxiety and depression. Additionally, 64% of students screening positive for anxiety indicated any substance use, 64% of students screening positive for depression indicated any substance use, and 65% of students screening positive for anxiety and depression indicated any substance use. As these rates were nearly identical, and to ease in interpreting relationships with our primary outcome of substance use, screen results were combined into a single measure – "Positive Screen for Anxiety and/or Depression."

Academic persistence was measured with the question "*I am confident that I will be able to finish my degree no matter what challenges I may face.*" Response options were: strongly agree, agree, somewhat agree, somewhat disagree, disagree, strongly disagree. As the distribution was skewed towards strongly agree and agree, this measure was dichotomized to agree (strongly agree, agree) and neutral/disagree (somewhat agree, somewhat disagree, disagree, strongly disagree) for the purposes of this analysis. Additionally, a question assessing the effect of mental health on academic performance (academic impairment) was included as a descriptive variable. The question "*In the past 4 weeks, how many days have you felt that emotional or mental difficulties have hurt your academic performance?*" included response options for none, 1–2 days, 3–5 days, 6 or more days. This question was also dichotomized to none or 1+ days to assess students with any level of academic impairment. This dichotomized operationalization of academic measures is consistent with prior publications (Keyes et al. 2012; Lipson and Eisenberg 2018).

2.4. Statistical analysis

Descriptive analyses were conducted to characterize the sample and compare pre-COVID (Fall 2017, Winter/Spring 2018, Fall 2018, Winter/Spring 2019, Fall 2019, Winter 2020) and COVID (March-December 2020) semesters. The Winter 2020 semester includes schools that participated in January and February 2020. In March 2020, the majority of states in the US mandated or recommended school closures, including higher education settings (Raifman et al. 2020). To comply with guidelines and reduce disease transmission, many universities limited or restricted on-campus living and in-person learning, dramatically altering the college student experience (Here's Our List of Colleges' Reopening Models 2020). Accordingly, all institutions that participated from March-May 2020 (7 schools) were included in the COVID time period along with all Fall 2020 institutions. Descriptive graphs separate the COVID time-period into Spring 2020 (March-May) and Fall 2020 (September-December) to highlight the effect of the pandemic in March 2020. A sensitivity analysis was conducted dropping the Winter/Spring 2020 semester (January to May). We found no significant differences in main outcomes when comparing Winter/Spring 2020 to other pre-COVID semesters, and therefore our primary analysis focuses on the time period comparison as listed above.

Differences in main outcomes for pre-COVID and COVID semesters were assessed using chi-square tests. A weighted logistic regression model was estimated for each binary outcome: substance use (any substance use, licit use, illicit use), mental health (positive screen for anxiety and/or depression), and academic persistence. All models were adjusted for student characteristics (age, gender identity, sexual orientation, and race). Additionally, the marginal effects of race, sexual orientation, and gender identity were calculated separately to report risk-adjusted predictions for each outcome variable. Marginal effects are risk-adjusted predictions which report the difference in probability of the binary outcome when it changes from 0 to 1, while all other covariates are held at the sample mean. We estimate our marginal effects for race, sexual orientation, and gender identity at representative values for time period: pre-COVID and March-December 2020. Significant differences in marginal effects (relative to reference group) are reported for March-December 2020 period for all main outcomes. Major shifts in marginal effects between pre-COVID and March-December 2020 periods are noted if present. All results reported in text are significant at the $p < 0.05$ level using Stata (Version 17). Unadjusted trends of main outcomes across all semesters are reported in Figs. 1–3. Complete results stratified by pre-COVID/March-December 2020 semesters are included in the Appendix (Table A1).

Table 1
Sample Characteristics (N=146,810)*

	Pre-COVID	March-December 2020
	(*n*=123,984)	(*n*=22,876)
Age	20.2±1.9	20.3±2.1
	%	%
Gender Identity		
Male	30.6	29.1
Female	67.3	68.2
TGNC	2.0	2.6
Race		
White	68.6	64.9
Asian	10.9	12.5
Latinx	9.7	10.4
Black	6.3	8.1
Other	4.4	4.0
Multiracial	9.4	10.2
Sexual Orientation		
Heterosexual	78.7	77.4
LGBQ	21.3	22.6

* Table values are weighted percentages with the exception of age presented as mean. Pre-COVID is defined as Fall 2017-Winter 2020. TGNC: transgender or gender non-conforming. Multiracial students are those that selected more than one race.

3. Results

3.1. Descriptive and univariate results

3.1.1. Sample characteristics

The sample was comprised of 146,810 undergraduate students. The average age was 20.2 years, with 67.5% identifying as female, 30.4% as male, and 2.1% as transgender or gender non-conforming (TGNC). The majority (68.6%) identified as white and as heterosexual (78.7%). Complete demographic information, stratified by COVID time-period, is reported in Table 1.

3.1.2. Substance use

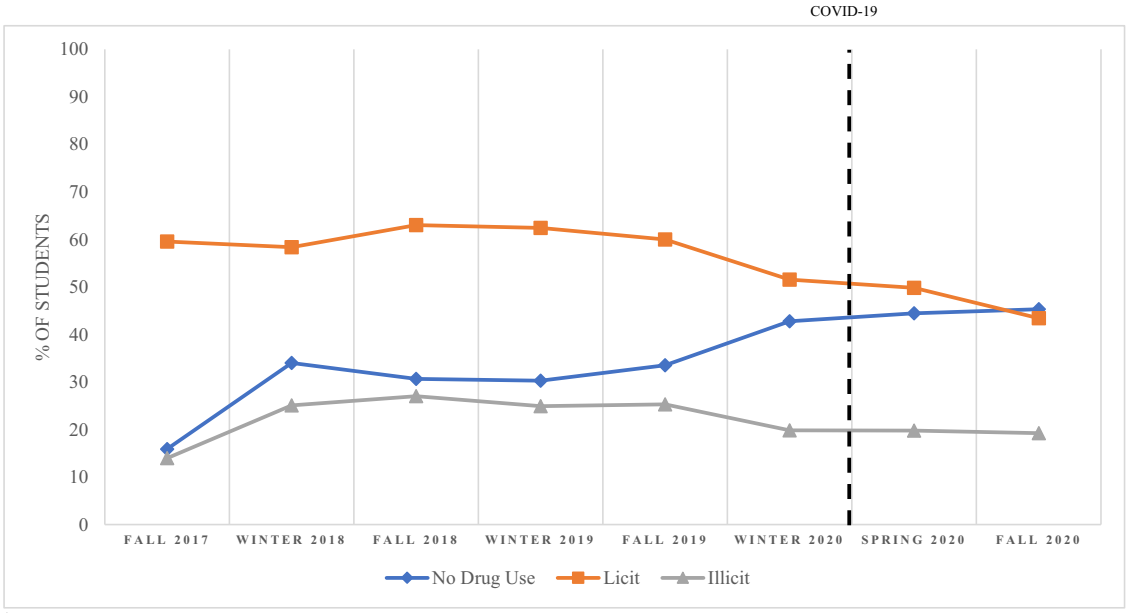
In March-December 2020, 48.7% of students reported any substance use compared to 61.0% in the pre-COVID semesters. This trend was evident across measures of substance use. Binge drinking decreased from 33.3% in pre-COVID semesters to 23.8% in March-December 2020. Licit substance use decreased from 58.7% in pre-COVID semesters to 45.2% in March-December 2020. Illicit substance use decreased from 22.9% in pre-COVID semesters to 19.4% in March-December 2020.

3.1.3. Mental health

In March-December 2020, 48.9% screened positive for anxiety and/or depression, which was significantly higher than during pre-COVID semesters (37.5%).

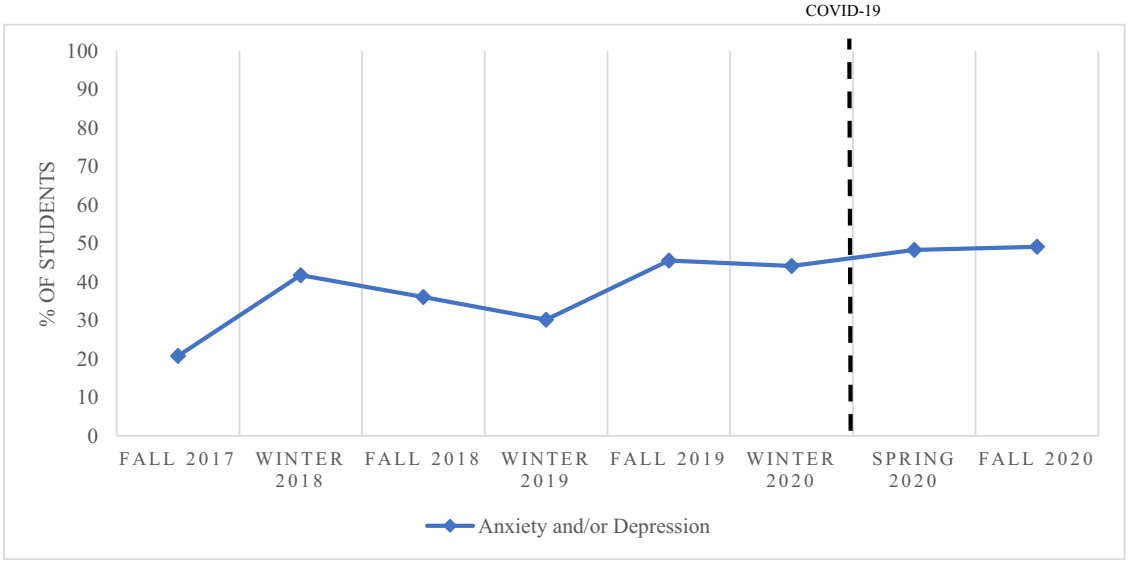
3.1.4. Academic persistence

In March-December 2020, 78.4% responded positively to academic persistence (confidence to finish degree), which was lower than the 81.9% in pre-COVID semesters. Additionally, 86.7% of students reported 1 or more days of academic impairment due to mental health, significantly higher than the 79.9% in pre-COVID semesters. Further, 30.9% of students in March-December 2020 had 6 or more days of emotional/mental difficulties affecting academic performance, significantly higher than 20.6% in pre-COVID semesters. Among students who lacked



[1]Licit: tobacco and/or alcohol use
[2]Illicit: marijuana, cocaine, heroin, opioids, methamphetamine, stimulants, ecstasy, hallucinogens, benzodiazepines, or kratom use

Fig. 1. Unadjusted Trends of Substance Use (2017-2020)[1,2]
[1]Licit: tobacco and/or alcohol use
[2]Illicit: marijuana, cocaine, heroin, opioids, methamphetamine, stimulants, ecstasy, hallucinogens, benzodiazepines, or kratom use



[1]Positive screen for anxiety and/or depression is a PHQ-9≥10 and/or GAD-7≥10

Fig. 2. Unadjusted Trends of Anxiety and/or Depression (2017-2020)[1]
[1]Positive screen for anxiety and/or depression is a PHQ-9≥10 and/or GAD-7≥10

confidence in finishing their degree, 94.5% indicated one or more days of emotional or mental difficulties in the past month. Further, 44.3% of students had 6 or more days of emotional or mental difficulties in the past month.

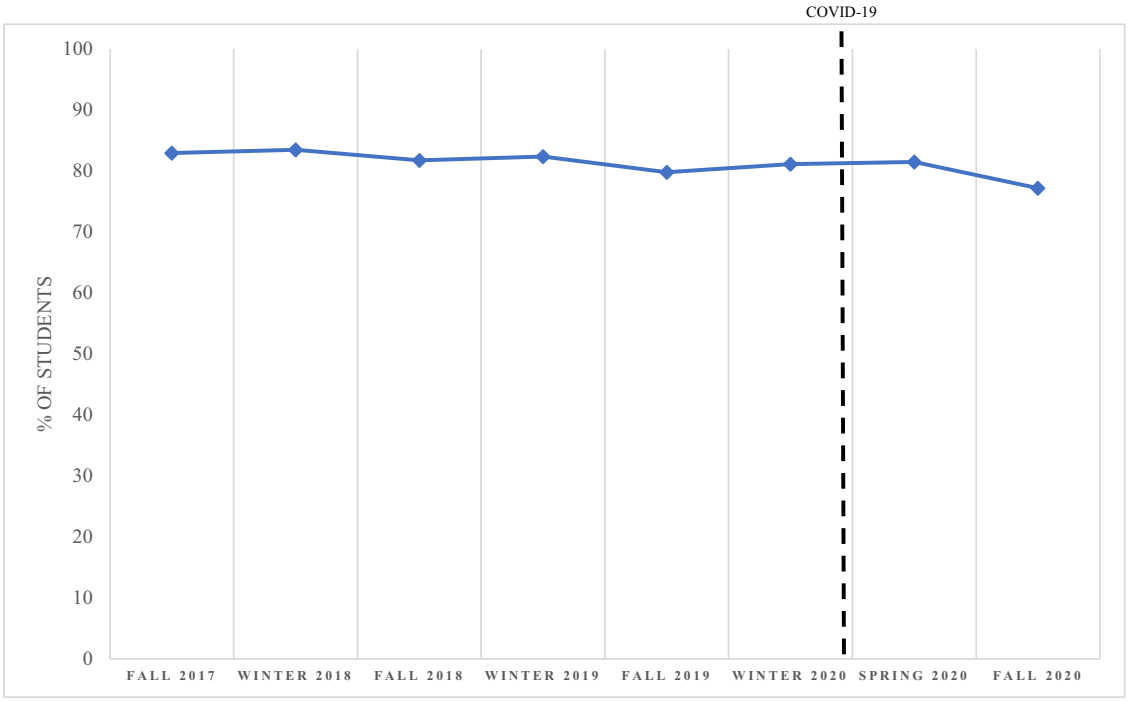
3.2. Multivariable results

Multivariable results for all main outcomes are reported in Table 2, and complete regression results are in the Appendix (Table A2). Significant marginal effects for race, gender identity, and sexual orientation are reported below and full results are presented in the Appendix (Table A3).

3.2.1. Substance use

Controlling for age, gender identity, sexual orientation, and race, students in the March-December 2020 period had 0.43 lower odds of reporting any substance use, 0.45 lower odds of reporting licit substance use, and 0.26 lower odds of reporting illicit substance use as compared to students in pre-COVID semesters ($p < 0.0001$, respectively).

In March-December 2020, Asian, Black, Latinx, and students identifying as "other" race/ethnicity each had a significantly lower probability of reporting substance use relative to White students. Black students had a 16.4 percentage point lower probability of licit substance use, differing significantly from a 17.2 percentage point lower probability in pre-



[1]Percent strongly agree/agree to "*I am confident that I will be able to finish my degree no matter what challenges I may face.*"

Fig. 3. Unadjusted Trends of Academic Persistence – 2017 through 2020[1]
[1]Percent strongly agree/agree to "I am confident that I will be able to finish my degree no matter what challenges I may face."

Table 2
Logistic Regression Analyses for Main Outcomes[1]

	Any Substance Use	Licit	Illicit	Positive Screen Anxiety and/or Depression[2]	Academic Persistence
Pre-COVID	*ref*	*ref*	*ref*	*ref*	*ref*
March-December	0.566***	0.546***	0.740***	1.70***	0.993
2020	(-38.08)	(-40.45)	(-16.45)	(34.25)	(0.706)

Odds ratios; t statistics in parentheses * $p<0.05$, ** $p<0.01$, *** $p<0.001$
[1] Each model controlled for age, gender identity, race, sexual orientation
[2] Positive screen for anxiety and/or depression is a PHQ-9≥10 and/or GAD-7≥10Complete results with all covariates are included in the Appendix (Table A1).

COVID semesters, relative to White students. In pre-COVID semesters, Asian students had an 8.8 percentage point lower probability of illicit substance use, which shifted to 7.2 percentage point lower probability in March-December 2020, relative to White students. TGNC students had a 9.1 percentage point lower probability of substance use, relative to cisgender male students. Illicit substance use declined significantly for female and TGNC students in March-December 2020 as compared to pre-COVID semesters, relative to male students (Table A3). LGBQ students had a 3.8 percentage point higher probability of substance use, relative to heterosexual students.

3.2.2. *Mental health*

Controlling for race, age, gender identity, and sexual orientation, students in the March-December 2020 period had 1.70 higher odds of screening positive for anxiety and/or depression as compared to students in pre-COVID semesters.

Relative to White students, Latinx, Black, and students identifying as "other" race/ethnicity had a significantly higher probability of screening positive for anxiety and/or depression in the March-December 2020 time period. Relative to male students, female and TGNC students had a higher probability of screening positive for anxiety and/or depression, as did LGBQ students relative to heterosexual students. Female students had 13.0 percentage point higher probability of screening positive for anxiety and/or depression in March-December 2020, increasing from 12.0 percentage point higher probability in pre-COVID semesters.

3.2.3. *Academic persistence*

In the March-December 2020, students had 0.01 lower odds of endorsing positive academic persistence, which was not significantly different than in pre-COVID semesters ($p = 0.706$). Female students had a significantly higher probability of endorsing positive academic persistence in March-December 2020, while TGNC students had a significantly lower probability of reporting positive academic persistence, relative to male students.

4. Discussion

Leveraging the large-scale HMS data and the diverse sample from campuses across the US, this is the first known study to confirm the impact of the pandemic on college-age AYA regarding mental health, substance use, and academic persistence. Our analysis is also able to demonstrate the important moderating effects of race, sexual orientation, and gender identity on these outcomes.

From March-December 2020, students were more likely to screen positive for anxiety or depression and less likely to engage in substance use than in the years prior to the pandemic. This is consistent with a previous analysis reporting that levels of stress, anxiety, loneliness, and depressive symptoms became worse during the pandemic, which was conducted among a small sample ($n = 212$) of Swiss students (Elmer, Mepham, and Stadtfeld 2020). Importantly, the high prevalence of symptoms in the pre-period (with 37.5% of our sample screening positive for anxiety and/or depression), renders our findings that students in March-December 2020 had 1.70 higher odds of screening positive much more worrisome. Our data confirms the troubling trend of worsening student mental health on college campuses, and campus mental health services should be prepared for an increased burden as students return to in-person classes and residence on campus Brown (2021).

A prior study reported that rates of harmful alcohol consumption and severe drug use increased in a sample including non-collegiate AYA (ages 18 to 35) during the COVID-19 pandemic (Horigian, Schmidt, and Feaster 2021). Conversely, in our analysis, substance use declined overall during the March-December 2020 period in this college student cohort, including both licit and illicit substance use. Consideration of strict socialization policies on college campuses during the pandemic may explain our findings. Many universities imposed penalties including expulsion or revoked admission for gathering with groups of students of a certain size Anderson (2020). With this in mind, fewer opportunities to socialize could have reduced events at which licit and illicit substances are typically used. However, it is important to note the challenges faced by those with substance use disorders (SUDs) or in recovery during the pandemic. Not only are those with SUDs at increased risk for poor COVID-19 outcomes, but accessing resources crucial to treatment and recovery was (and is) limited during the pandemic (Jemberie et al. 2020; National Institute on Drug Abuse 2021). Lastly, increased isolation and stress as a result of the pandemic can increase the likelihood of people using alone (Patterson et al. 2021). This can lead to heightened risk of overdosing without help available, which can be life threatening (Patterson et al. 2021). Even prior to the pandemic, AYA who reported solitary drinking were more likely to have depressive symptoms, suicidal ideation, and lower distress tolerance, which can lead to developing an alcohol use disorder (Creswell 2021; Keough et al. 2015; Williams, Vik, and Wong 2015). As the majority of colleges have resumed in-person classes, and students return to regular socialization practices, substance use may rise to pre-pandemic levels. However, as the pandemic and spread of COVID-19 persists, students can experience isolation and stress and differing levels, which may lead to unhealthy substance use habits or overdose events. Some schools have adopted mitigation strategies, such as screening for substance use at student health centers or increasing access to naloxone on campus, in an effort to curb negative outcomes associated with substance use (Hill et al. 2020; Jeffery et al. 2017; McNeely et al. 2019; Panther, Bray, and White 2017). Similar preventative measures and programs are encouraged to ensure the health and safety of students during this critical time-period.

As compared to students in pre-COVID semesters, students in the March-December 2020 time-period were significantly more likely to have mental/emotional difficulties that hurt academic performance. Importantly, the percentage of students indicating the most academic impairment due to mental health (6 or more days) was also significantly higher in the COVID period.

This study also has important implications for understanding drivers of inequalities in college student populations. Our results indicate that Latinx, Black, and students identifying as “other” race/ethnicity had a significantly higher probability of screening positive for anxiety and/or depression relative to White students. This is an important finding not only for identifying racial disparities in mental health, but also, given established relationships between mental health and academic performance, for improving persistence and retention in higher education. Prior to the pandemic, clear inequities for BIPOC students in higher education have been reported in the literature (Banks and Dohy 2019). BIPOC students have, on average, lower rates of academic persistence, retention, and graduation, which can have lifelong impacts on well-being, employment opportunities, and economic outcomes (Banks and Dohy 2019). This study found significantly lower rates of substance use among racial and ethnic minority students, while maintaining similar rates of academic persistence as compared to other student groups. Lower rates of substance use among racial and ethnic minority students may be a protective factor for positive academic persistence during the COVID-19 pandemic. It will be important to continue to examine inequalities in higher education moving forward to understand long-term effects of the pandemic on mental health, college enrollment, and academic performance.

4.1. Limitations

Though the present study is strengthened by the multi-campus study design, random sampling at the student level, and the use of validated screening tools to measure mental health, this study had several limitations. First, these data do not provide longitudinal information on the same set of students. However, demographic comparisons between the pre-COVID and March-December 2020 period reveal no significant differences in student characteristics in the HMS samples. Second, as previously mentioned, survey response rates are a concern. However, use of sample probability weights from administrative data corrects for some of these concerns along known characteristics of student populations on participating campuses. It is also possible that COVID-19 affected likelihood of survey response due to a variety of factors, such as having active infection, supporting family members, or working more to due to financial distress at the time of the survey. While we describe rates of substance use and anxiety and/or depression, future research should investigate utilization of mental health or substance use services – which may have been affected by COVID-19. Additionally, we group substances into licit and illicit categories, as is commonly done when analyzing substance use of young populations (Eaton et al. 2010; Primack et al. 2012; Schilling et al. 2017). However, future research should investigate different types of individual substances and their effect on anxiety and/or depression among college students. Lastly, data on academic persistence and academic impairment are self-reported and may not predict future persistence. However, understanding enrolled students’ perceptions of their future academic persistence is particularly important for prevention of dropout, and is therefore meaningful in this context.

5. Conclusions

Using the most comprehensive mental health data in college student populations, this is the first study to describe the impact of the pandemic on undergraduate students’ mental health, substance use, and academic persistence/impairment. College students in March-December 2020 had higher rates of anxiety and/or depression, but reduced rates of substance use compared to pre-COVID semesters. Our analysis revealed that students are reporting their mental health has negatively affected students’ academic performance at higher rates during the pandemic than before. While colleges have focused attention on addressing academic persistence/retention and mental health, these discussions rarely occur together. This study points to the importance of bringing these conversations together to support prevention efforts and advance equity in these important markers of the college experience, particularly in the wake of the COVID-19 pandemic.

Author disclosures

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Contributors

All authors contributed significantly to the preparation and submission of this manuscript and the order reflects the contribution. All authors have approved the final draft for submission.

Conflicts of Interest

The authors have no conflicts of interest to disclose.

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Appendix A

Table A1
Main Outcomes by COVID Semester

	Pre-COVID		March-December 2020		
	No.	%	No.	%	*p*-value
Positive Screen Anxiety and/or Depression					
Yes	49,555	38.0	8,103	49.1	<0.001
Substance Use					
Any	78,900	60.6	7,783	47.2	<0.001
Licit	75,931	58.3	7,165	43.4	<0.001
Illicit	29,601	22.7	3,171	19.2	<0.001
Academic Persistence					
Strongly agree/Agree	105,707	81.9	12,704	77.2	<0.001

Table A2
Coefficients for all Regression Models

	Substance Use	Licit	Illicit	Positive Screen Anxiety and/or Depression	Academic Persistence
Pre-COVID	*ref*	*ref*	*ref*	*ref*	*ref*
COVID	0.530***	0.507***	0.730***	1.689***	0.914***
	(-36.87)	(-39.32)	(-14.86)	-29.33	(-4.08)
Age	1.167***	1.169***	1.010**	1.043***	1.041***
	-44.26	-45.55	-3.26	-13.84	-9.72
Male	*ref*	*ref*	*ref*	*ref*	*ref*
Female	0.993	1.011	0.715***	1.715***	1.186***
	(-0.58)	-0.93	(-23.79)	-41.47	-10.19
TGNC	0.673***	0.646***	0.671***	3.174***	0.855***
	(-9.75)	(-10.85)	(-9.21)	-24.98	(-3.37)
White	*ref*	*ref*	*ref*	*ref*	*ref*
Asian	0.484***	0.491***	0.561***	1.008	1.027
	(-41.77)	(-40.98)	(-24.44)	-0.43	-1.07
Latinx	0.757***	0.727***	0.965	1.209***	0.972
	(-14.94)	(-17.30)	(-1.67)	-9.73	(-1.14)
Black	0.523***	0.486***	0.898***	1.150***	0.997
	(-30.04)	(-33.24)	(-4.16)	-5.96	(-0.11)
Other	0.639***	0.618***	1.002	1.396***	0.98

(*continued on next page*)

Table A2 (*continued*)

	Substance Use	Licit	Illicit	Positive Screen Anxiety and/or Depression	Academic Persistence
	(-18.34)	(-19.75)	-0.07	-12.73	(-0.62)
Heterosexual	*ref*	*ref*	*ref*	*ref*	*ref*
LGBQ	1.173***	1.088***	1.733***	2.300***	0.737***
	-11.06	-5.95	-35.69	-57.93	(-17.14)
PHQ-9	1.016***	1.011***	1.044***		0.906***
	-11.25	-7.73	-28.18		(-58.05)
GAD-7	1.021***	1.020***	1.004*		0.994**
	-13.06	-12.65	-2.07		(-2.94)
None				*ref*	*ref*
Licit				1.033*	1.117***
				-2.36	-6.19
Illicit				1.593***	0.903***
				-30.42	(-5.32)

Exponentiated coefficients; t statistics in parentheses
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table A3
Marginal Effects (dy/dx) of Specific Subpopulations for Main Outcomes[1]

		Substance Use		Licit		Illicit		Positive Screen Anxiety and/or Depression		Academic Persistence	
		dy/dx	**SE**	**dy/dx**	**SE**	**dy/dx**	**SE**	**dy/dx**	**SE**	**dy/dx**	**SE**
Gender											
Male		*ref*	*ref*	*ref*	*ref*	*ref*	*ref*	*ref*	*ref*	*ref*	*ref*
Female	Pre-COVID	-0.0016	0.003	0.003	0.003	-0.059***	0.003	0.120***	0.003	0.024***	0.002
	March-Dec 2020	-0.0017	0.003	0.003	0.003	-0.050***	0.002	0.130***	0.003	0.025***	0.002
TGNC	Pre-COVID	-0.092***	0.010	-0.103***	0.009	-0.069***	0.007	0.265***	0.011	-0.029***	0.007
	March-Dec 2020	-0.091***	0.010	-0.097***	0.009	-0.058***	0.006	0.267***	0.010	-0.030***	0.007
Race											
White		*ref*	*ref*	*ref*	*ref*	*ref*	*ref*	*ref*	*ref*	*ref*	*ref*
Asian	Pre-COVID	-0.171***	0.004	-0.169***	0.004	-0.088***	0.003	0.002	0.004	0.003	0.003
	March-Dec 2020	-0.170***	0.004	-0.162***	0.004	-0.072***	0.003	0.002	0.004	0.003	0.003
Latinx	Pre-COVID	-0.064***	0.004	-0.075***	0.004	-0.006	0.004	0.043***	0.004	-0.006	0.003
	March-Dec 2020	-0.067***	0.004	-0.076***	0.004	-0.005	0.003	0.043***	0.005	-0.006	0.004
Black	Pre-COVID	-0.152***	0.005	-0.172***	0.005	-0.018***	0.004	0.031***	0.005	-0.001	0.004
	March-Dec 2020	-0.152***		-0.164***	0.005	-0.016***	0.004	0.033***	0.005	-0.001	0.004
Other	Pre-COVID	-0.104***	0.006	-0.114***	0.006	0.0003	0.005	0.076***	0.006	-0.005	0.004
	March-Dec 2020	-0.107***	0.006	-0.112***	0.005	0.0003	0.004	0.078***	0.006	-0.005	0.005
Sexual Orientation											
Heterosexual		*ref*	*ref*	*ref*	*ref*	*ref*	*ref*	*ref*	*ref*	*ref*	*ref*
LGBQ	Pre-COVID	0.036***	0.003	0.020***	0.003	0.102	0.003	0.197***	0.003	-0.049	0.003
	March-Dec 2020	0.038***	0.003	0.020***	0.003	0.086	0.003	0.196***	0.003	-0.052	0.003

[1] Note: SE = standard error. Reference categories (Male, White and Heterosexual) were excluded. Dy/dx values represent the difference in probability of reporting "yes" for main outcomes, also called risk adjusted predictions. Models control for age, gender identity, sexual orientation, and race. Institution-level fixed effects are also included. *$p<0.05$; **$p<0.01$; ***$p<0.001$

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